

**Course: Post Graduate Diploma in Water, Sanitation and Hygiene Promotion – Final Exam**

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**Final Exam**

1. Diarrhea among children under 5 is common in many rural villages. What environmental factors or practices may cause diarrhea in young children? Explain three ways to prevent it
2. Think about the possible types of pollution that could be produced from a health center.
   1. List the types of pollution that could be produced, giving one example of each type.
   2. Describe the two main approaches to pollution management. Outline the pollution management methods that could be used for the pollutants you have listed.
3. Give three reasons for incorporating plans for M&E during the early stages of a project’s development.
4. Explain four factors that are important when choosing a sanitation technology
5. Define Sustainability. Explain four factors that can be used to foster sustainability in WASH projects.

b. Giving reasons explain 5 conditions that will help in improving the water supply situation in your country.

1. What are the key factors to be considered when planning a new landfill in small and medium-sized towns? List at least four factors.

b) Explain how incineration differs from open burning

1. List and briefly describe the measures by which the success or otherwise of a public–private partnership providing water supply services can be assessed.
2. What are the possible interventions to manage the solid waste in an emergency situation? Explain at least three actions that could be taken.
3. What are the most important questions you would need to address in a rapid assessment of an emergency?
4. Filtration and disinfection are important water treatment processes. Briefly describe each of these processes and explain their role in making water safe to drink
5. List the five factors that make a water source ideal to use.
6. **Diarrhea among children under 5 is common in many rural villages. What environmental factors or practices may cause diarrhea in young children? Explain three ways to prevent it**

**Introduction**

Childhood diarrhea accounts for nearly 1.3 million deaths a year among children under 5 years of age making it the second most common cause of childhood mortality globally after pneumonia (UNICEF and WHO. 2009). Mortality of children below the age of five in Africa is more than 80% (Akinyemi et al. 2013). Of the 15 countries in Africa where the under-five child mortality is 75%, Kenya is ranked at number 10. Causes of childhood mortality differ from one country to another but pneumonia and diarrhea remain the illnesses that are most often associated with child deaths (Mukhtar et al. 2009). In Africa, a child experiences five episodes of diarrhea per year, and 800,000 children die each year from diarrhea related dehydration (Woldemichael, 2001). In Kenya, the mortality rate of children under the age of five years due to diarrhea is very high about 16% surpassing deaths from HIV and Malaria combined (Njuguna and Muruka, 2011).

There is a relationship between environmental factors and the occurrence of diarrhea in children. Such factors include: water quantity, access to improved water sources, availability of toilet facilities, compound hygiene, housing condition, and refuse disposal (Woldemichael, 2001). Globally, more than 125 million children under-five years of age live in households without access to an improved drinking-water source, and more than 280 million of these children live in households without access to improved sanitation facilities (Black et al. 2003). In the developing world, unsafe drinking water, inadequate availability of water for hygiene and lack of access to sanitation together contribute to about 88 % of deaths from diarrheal diseases or more than 1.5 million deaths in children under- five each year (Black et al. 2003).

Every child in Kenya under the age of five experiences an average of three bouts of diarrhea every year (KNBS and ICF Macro, 2010). This could be attributed to the quality of the water supply, mother’s literacy, housing conditions, and the level of development of the villages in which the children live (Vani, 2004). Maternal education has been found to influence the perception of mothers on childhood diarrhea and increased child health improvements. In others studies, the relationship between maternal characteristics such as education, wealth and child diarrhea is not direct but rather is moderated by other factors such as residence differences (Njeri and Muriithi, 2013). There is need to understand the determinants of diarrhea as it has far reaching consequences on child nutrition, survival and development (Weisz et al. 2011).

**Literature review and theoretical framework**

Maternal factors such as mother’s age and education level and household factors such as sources of drinking water, toilet facilities, water treatment, household size, number of children and bottle feeding are important in explaining child health outcomes. Several studies have found that demographic variables play a role in diarrhea prevalence. For example, children of more educated mothers tend to have lower diarrhea prevalence, irrespective of water and sanitation conditions and this is due to better understanding of proper hygiene (Ahiadeke, 2000). Other studies have found that child diarrhea incidence was significantly lower when mothers had secondary education, compared to mothers with no education. Mother’s education was a significant determinant of diarrhea (Ahiadeke, 2000; Boadi and Kuitunen, 2005). Other sociodemographic variables that significantly predicted lower diarrhea incidence among children under five included: higher family income (Boadi and Kuitunen, 2005), older child’s age (Arif and Ibrahim, 1998), urban residence (Arif and Ibrahim, 1998), and female sex (Van Derslice and Briscoe, 1995; Arif and Ibrahim, 1998).

A number of studies found association between water quality as intervening variable and diarrhea incidence. For example, in a 2002 logistic regression analysis of data from three East African countries, indicated that households with piped water connections did not have significantly lower diarrhea likelihood than households that lacked piped water (Tumwine et al. 2002). Non protected sources of drinking water have been significantly associated with an increased risk of diarrhea in a number of studies (Ekanem et al. 1991; Manun’Ebo et al. 1994; Mock et al. 1995). In a comparison of urban and rural communities, this association held true only for the latter (Mock et al. 1995).

The protective effect of exclusive breast feeding against diarrhoeal disease in the first 4–6 months of life has been reported (Golding et al., 1997). This is attributed to the immune properties of breast milk and less exposure to pathogens in contaminated milk, food, bottles, or teats (Lawrence and Lawrence 1999). These contamination and inadequate sterilization pose less of a problem in developed than developing countries, hence the greater risk of child diarrhea through breast feeding in developing countries where poverty, poor hygiene, and infectious diseases are common. Quigley et al., (2006) report that breast feeding was associated with significantly less diarrhoeal disease and formula fed infants experienced more diarrhoea if their bottles/teats were not sterilized.

Research has suggested that children in the 6 to 18 month age range are most likely to develop persistent diarrhea (Moy et al. 1991; Thea et al. 1993). An association between age and increased rates of persistent diarrhea has however not been consistently demonstrated in other developing countries (WHO, 1988).

From the above evidence, independent variables such as demographic and maternal characteristics influence childhood diarrhea either directly, or through intervening variables such as water and sanitation, household size and child feeding practices.

1. **1 Explain three ways to prevent Diarrhea among children under 5 is common in many rural villages;**
2. For children of breastfeeding age: Exclusive breastfeeding until 6 months should be promoted as it will prevent diseases including malnutrition and diarrhea
3. Access to clean and safe water will be another way to prevent diarrheal diseases
4. Adequate sanitation, such as avoidance of open defecation, proper use of latrines, handwashing. They are important in the prevention of diarrhea.
5. Hygiene promotion, including household hygiene such as cleaning the utensils, cleaning and covering water storage facilities, etc.
6. **Think about the possible types of pollution that could be produced from a health center.**
   1. **List the types of pollution that could be produced, giving one example of each type.**

Health centres and clinics create different kinds of solid waste including used needles, gloves and bandages contaminated with body fluids from patients. These are all hazardous wastes that can cause harm to people. Waste in healthcare facilities is considered critical because new infections can occur in people dealing with the waste if it is not handled safely. Healthcare facilities are usually provided with incinerators that burn the waste at high temperatures to kill pathogens and remove any risk of new infections. Some facilities may have special storage containers for ‘sharps’ (i.e. items such as needles and razor blades), covered placenta pits for anatomical waste (blood, body parts), and open pits for other medical waste ( Open, 2018).

* 1. **Describe the two main approaches to pollution management. Outline the pollution management methods that could be used for the pollutants you have listed.**

The environmental consequences of rapid industrialization have resulted in countless incidents of land, air and water resources sites being contaminated with toxic materials and other pollutants, threatening humans and ecosystems with serious health risks. More extensive and intensive use of materials and energy has created cumulative pressures on the quality of local, regional and global ecosystems ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

Before there was a concerted effort to restrict the impact of pollution, environmental management extended little beyond laissez-faire tolerance, tempered by disposal of wastes to avoid disruptive local nuisance conceived of in a short-term perspective. The need for remediation was recognized, by exception, in instances where damage was determined to be unacceptable. As the pace of industrial activity intensified and the understanding of cumulative effects grew, a *pollution control* paradigm became the dominant approach to environmental management ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

Two specific concepts served as the basis for the control approach:

* the *assimilative capacity* concept, which asserts the existence of a specified level of emissions into the environment which does not lead to unacceptable environmental or human health effects
* the *principle of control* concept, which assumes that environmental damage can be avoided by controlling the manner, time and rate at which pollutants enter the environment ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

Under the pollution control approach, attempts to protect the environment have especially relied on isolating contaminants from the environment and using end-of-pipe filters and scrubbers. These solutions have tended to focus on media-specific environmental quality objectives or emission limits, and have been primarily directed at point source discharges into specific environmental media (air, water, soil) ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

**Applying Pollution Control Technologies**

Application of pollution control methods has demonstrated considerable effectiveness in controlling pollution problems - particularly those of a local character. Application of appropriate technologies is based on a systematic analysis of the source and nature of the emission or discharge in question, of its interaction with the ecosystem and the ambient pollution problem to be addressed, and the development of appropriate technologies to mitigate and monitor pollution impacts ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

In their article on air pollution control, Dietrich Schwela and Berenice Goelzer explain the importance and implications of taking a comprehensive approach to assessment and control of point sources and non-point sources of air pollution. They also highlight the challenges - and opportunities - that are being addressed in countries that are undergoing rapid industrialization without having had a strong pollution control component accompanying earlier development ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

Marion Wichman-Fiebig explains the methods that are applied to model air pollutant dispersion to determine and characterize the nature of pollution problems. This forms the basis for understanding the controls that are to be put into effect and for evaluating their effectiveness. As the understanding of potential impacts has deepened, appreciation of effects has expanded from the local to the regional to the global scale ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

Hans-Ulrich Pfeffer and Peter Bruckmann provide an introduction to the equipment and methods that are used to monitor air quality so that potential pollution problems can be assessed and the effectiveness of control and prevention interventions can be evaluated ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

John Elias provides an overview of the types of air pollution controls that can be applied and the issues that must be addressed in selecting appropriate pollution control management options ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

The challenge of water pollution control is addressed by Herbert Preul in an article which explains the basis whereby the earth’s natural waters may become polluted from point, non-point and intermittent sources; the basis for regulating water pollution; and the different criteria that can be applied in determining control programmes. Preul explains the manner in which discharges are received in water bodies, and may be analysed and evaluated to assess and manage risks. Finally, an overview is provided of the techniques that are applied for large-scale wastewater treatment and water pollution control ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

A case study provides a vivid example of how wastewater can be reused - a topic of considerable significance in the search for ways that environmental resources can be used effectively, especially in circumstances of scarcity. Alexander Donagi provides a summary of the approach that has been pursued for the treatment and groundwater recharge of municipal wastewater for a population of 1.5 million in Israel ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

**Comprehensive Waste Management**

Under the pollution control perspective, waste is regarded as an undesirable by-product of the production process which is to be contained so as to ensure that soil, water and air resources are not contaminated beyond levels deemed to be acceptable. Lucien Maystre provides an overview of the issues that must be addressed in managing waste, providing a conceptual link to the increasingly important roles of recycling and pollution prevention ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

In response to extensive evidence of the serious contamination associated with unrestricted management of waste, governments have established standards for acceptable practices for collection, handling and disposal to ensure environmental protection. Particular attention has been paid to the criteria for environmentally safe disposal through sanitary landfills, incineration and hazardous-waste treatment ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

To avoid the potential environmental burden and costs associated with the disposal of waste and promote a more thorough stewardship of scarce resources, waste minimization and recycling have received growing attention ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

**Shifting Emphasis to Pollution Prevention**

End-of-pipe abatement risks transferring pollution from one medium to another, where it may either cause equally serious environmental problems, or even end up as an indirect source of pollution to the same medium. While not as expensive as remediation, end-of-pipe abatement can contribute significantly to the costs of production processes without contributing any value. It also typically is associated with regulatory regimes which add other sets of costs associated with enforcing compliance ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

While the pollution control approach has achieved considerable success in producing short-term improvements for local pollution problems, it has been less effective in addressing cumulative problems that are increasingly recognized on regional (e.g., acid rain) or global (e.g., ozone depletion) levels ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

The aim of a health-oriented environmental pollution control programme is to promote a better quality of life by reducing pollution to the lowest level possible. Environmental pollution control programmes and policies, whose implications and priorities vary from country to country, cover all aspects of pollution (air, water, land and so on) and involve coordination among areas such as industrial development, city planning, water resources development and transportation policies ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

Thomas Tseng, Victor Shantora and Ian Smith provide a case study example of the multimedia impact that pollution has had on a vulnerable ecosystem subjected to many stresses - the North American Great Lakes. The limited effectiveness of the pollution control model in dealing with persistent toxins that dissipate through the environment is particularly examined. By focusing on the approach being pursued in one country and the implications that this has for international action, the implications for actions that address prevention as well as control are illustrated ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

As environmental pollution control technologies have become more sophisticated and more expensive, there has been a growing interest in ways to incorporate prevention in the design of industrial processes - with the objective of eliminating harmful environmental effects while promoting the competitiveness of industries. Among the benefits of pollution prevention approaches, clean technologies and toxic use reduction is the potential for eliminating worker exposure to health risks ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

David Bennett provides an overview of why pollution prevention is emerging as a preferred strategy and how it relates to other environmental management methods. This approach is central to implementing the shift to sustainable development which has been widely endorsed since the release of the United Nations Commission on Trade and Development in 1987 and reiterated at the Rio United Nations Conference on Environment and Development (UNCED) Conference in 1992 ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

The pollution prevention approach focuses directly on the use of processes, practices, materials and energy that avoid or minimize the creation of pollutants and wastes at source, and not on “add-on” abatement measures. While corporate commitment plays a critical role in the decision to pursue pollution prevention (see Bringer and Zoesel in *Environmental policy*), Bennett draws attention to the societal benefits in reducing risks to ecosystem and human health—and the health of workers in particular. He identifies principles that can be usefully applied in assessing opportunities for pursuing this approach ([Spiegel,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/4057-spiegeljerry) [Maystre, Lucien,](http://iloencyclopaedia.org/part-vii-86401/environmental-pollution-control/itemlist/users/3446-maystrelucieny) 2015).

1. **Give three reasons for incorporating plans for M&E during the early stages of a project’s development.**

It’s very important to plan monitoring activities during the earliest stages of project development — they should be integrated into project activities and not be added on as an afterthought. Monitoring requires regular and timely feedback in the form of reports from implementers to project managers so they can keep track of progress. These reports provide information about activities and what has been achieved in terms of outputs. They also include financial reports that give information on budgets and expenditure. With this information, managers can assess progress and plan the next steps for their project (AIPMS, 2018).

**Why is M&E so important?**

A well-managed M&E system will allow stakeholders to:

* Track progress: M&E assesses inputs (expenditure), outputs and outcomes, which enables managers to track progress towards achieving specific objectives.
* Measure impact: M&E reduces guesswork and possible bias in reporting results by asking questions such as: What is the impact of the programme? Are the expected benefits being realised? Is sanitation improving? Are waste recoveryrates increasing?
* Increase accountability: M&E can provide the basis for accountability if the information gathered by the M&E process is reported and shared with users and other stakeholders at all levels.
* Inform decision making: M&E provides evidence about the successes and failures of current and past projects that planners and managers need to make decisions about future projects. It should also encourage reflection on lessons learned in which managers ask themselves questions like ‘what worked well in this project?’ and ‘what can we do better next time?’.
* Encourage investment: a credible M&E system builds trust and confidence from government and donors which will increase possibilities of further investment.

Build capacity: a sound M&E system supports community participation and responsibility. It encourages the user communities to look regularly at how well their sanitation and waste schemes are working, what changes need to take place in sanitation and waste behaviours, what health benefits are resulting and what more needs to be done. It enables a community to build its own capacity, recognise its own successes and record them regularly (AIPMS, 2018)..

Reporting on monitoring activity is essential because otherwise the information cannot be used. It is no use collecting data and then filing it away without sharing it. As noted above, one of the reasons for undertaking M&E is to inform decision makers and enable lessons to be learned and therefore they need to be provided with the information in a timely way for that benefit to be realized (AIPMS, 2018).

1. **Explain four factors that are important when choosing a sanitation technology**

The selection of an appropriate technology from a range of possibilities is the key to the successful and sustainable operation of any facility. Choice of technology is often considered a simple process, but is usually quite complex requiring careful assessment of factors, consultation with the beneficiaries and the operating authority, and an understanding of the integration of factors affecting the sustainability of a system.

The process of selecting an option for a particular application may follow a step-wise sequence as shown in the layout below.

**Step 1:** Confirm goal and objectives What is to be achieved and why? Is it a realistic goal and will it address the main problem(s)? Are there sub-objectives that should be prioritized?

**Step 2:** Analysis of constraints and promoters Social issues Health issues Technological issues Economic issues Financial issues Institutional issues Environmental issues

**Step 3:** Output Selection of technology Specification of implementation methodology Plan for ongoing operation, maintenance and hygiene awareness Economic plan including sustainability of jobs and financing of O&M

1. **Define Sustainability. Explain four factors that can be used to foster sustainability in WASH projects.**

**Introduction**

The Brundtland report has the status of being the launching pad for the global agenda on sustainability. That is why the Brundtland report’s definition of sustainability is a safe starting point to use as a base: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.It is a fairly broad and general definition: What, for example, are current and future needs? Just as with the concept of growth, there are different definitions of what sustainability is and there will always be different views on what values one should attach to biodiversity, landscapes, habitats etc.

In the debate in the West, the Brundtland report is regarded as having put the global environment on the agenda, but one of its great strengths and reasons for its impact was that it connected global environmental issues to the need for global development and reduction of poverty. Until then, there had been a conflict of interest between the rich countries’ increasing focus on the environment and the poor countries’ focus on poverty. The Indian leader, Indira Gandhi expressed it as follows at the UN’s Stockholm conference in 1972, which became one one of the launchpads for the UN’s environmental program UNEP.

“Aren’t poverty and need the most important pollutions? How can we talk to villagers and slum-dwellers of the need to protect the air, the ocean and rivers when their own life is contaminated? The environment cannot be improved in conditions of poverty” (http://www.bu.dk/ pages/25.asp).

The Brundtland report thus aligned social sustainability as a necessary element. This is also the reason for it being so positive towards economic growth, as the case is: “What is needed now is a new period of economic growth - a growth that is strong as well as socially and environmentally stable.”

It is important to bear in mind that sustainability is not a definitive concept. It means that there will always be a political position - either conscious or unconscious - in relation to the choice of development in environment and production. Generally, we distinguish between two concepts of sustainability, so-called “weak” and “strong” sustainability. (See OECD’s Glossary of Statistical Terms http://stats. oecd.org/glossary/search.asp).

**Two General Conceptions of Sustainability**

These can be characterized briefly as follows: - Weak sustainability: Depletion of resources, breaking down of ecosystems and species extinction can be compensated for if this takes place in a process that supports opportunities for continued maintenance or expansion of economic opportunities. Nature, in this respect, is a form of capital, which can be substituted with other kinds of capital. Development is sustainable for as long as it does not harm the prospects of the continued fulfillment of economic necessity. - Strong sustainability: this viewpoint lays emphasis on development not leading to irretrievable loss of resources. Plants and animal species, ecosystems and raw materials have a value in themselves and not just as input in the economic process.

Many of the indicators for development, which have been suggested as alternatives or supplements to the GDP concept can be classified according to these two sustainability perspectives (Neumeyer). These two perspectives lead to potentially fundamentally different views of the given pattern of development. They weigh very differently between economy and ecology and thus also give vastly different policy recommendations. They are, however, not necessarily always in conflict with each other. In Danish environmental policy, conservation legislation is a classic example of a strong sustainability perspective, whilst weak sustainability is a characteristic of everything from the issuing of environmental permits for businesses and agriculture to building permits for housing and to the construction of new infrastructure. The discussion is, in other words, just as old as it is fundamental.

It should also be mentioned that there can be fundamental uncertainty about the consequences of the economic activities. It is often here that the main part of the debate is located. The most recent example is, of course, the question of global climate, where there have been attempts to calculate future consequences of the presentday emissions by means of constructing large computer models of the global climate, which are regularly upgraded with data from e.g sea and air temperatures, drilling of the inland ice in Greenland and with subsystems such as e.g feedback effects from clouds, the sea and any melting of tundra. The prognoses will thus also be reviewed regularly.

In the light of these uncertainties, the proponents of strong sustainability will presumably refer to the “precautionary principle”.

There is a tendency for sustainability to be identified with reluctance, almost abstinence, and that the concept also has moral overtones. Thus, it may also appear to some as a boring and “born-again” concept, which preaches constantly. It is interesting that the Brundtland report itself foresaw some of these aspects, as is evident in the following quote:

*“Ultimately, sustainable development is not in a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs.”*

b. **Giving reasons explain 5 conditions that will help in improving the water supply situation in your country**

**Introduction**

Slow progress toward full water supply coverage at a national level may be related to national GDP, government effectiveness, or shortages of water. We have explored the relationship between these three variables and coverage by statistically analysing the most recent available global datasets. Unsurprisingly, given the small amounts of water needed for domestic use, the national availability of water resources was unimportant for water supply coverage. Its significance more locally is considered below. However, the proportion of people with access to safe water was correlated with GDP (p,0.001) and government effectiveness (p,0.001). In a multivariate model, GDP remained the only significant independent covariate. Clearly, therefore, a low GDP is a major challenge facing efforts to improve water supplies. Below we discuss some of the other reasons for slow progress (Paul, MacDonald , Carter, 2010).

**Government Effectiveness**

Government effectiveness in low-income countries is often poor, and governments often lack capacity or show institutional weaknesses. Such weaknesses range from lack of individual professional skills, understaffing, poor motivation, inadequate resources, and poor organisational management, through to inappropriate policies handed down to local government from central authorities. In addition, corruption has been highlighted as a major threat to service delivery. Limited effectiveness of the Ministries and local government authorities responsible for water supply can be exacerbated by insufficient political commitment at the highest governmental levels and by the weaknesses of private companies contracted to carry out construction or system management. Furthermore, the professional and technical staff of central government and local authorities often find their own high levels of commitment constrained by the systems within which they work. **Therefore, government effectiveness is one of the area that should be improve in a country such as South Sudan in in order to improve access to water supply** (Paul, MacDonald , Carter, 2010).**.**

**The Availability of Water Resources**

Sustainable domestic water supplies depend on the availability of reliable water resources that can be easily developed. Fresh water resources are not spread evenly across the globe. Most of the wealthier areas of the world experience sufficiently frequent rainfall to replenish rivers, reservoirs, and aquifers reliably, and have the capacity to store and transfer that water. Nevertheless, even wealthy countries are not free from the problems of occasional droughts, as recently seen in Spain and Australia. In many parts of Africa and Asia, the long dry season and dispersed nature of many of the populations who currently have no reliable water supply mean that the development of groundwater (a natural reservoir) is the only realistic option for significantly improving drinking water coverage. Consequently, statistics on national water resources are not a good indicator of water scarcity for much of the global population. The important factor is the availability of water resources (usually groundwater) close to the point of need. Groundwater is not a panacea, however, and its development and use need careful attention. First, in some locations even small-scale groundwater supplies can be difficult to find and develop. Such locations are often a priority for water supply intervention since they are beset with diseases related to high dependence on contaminated surface water sources. A lack of appreciation of the variability in the nature and occurrence of water resources is a major reason for expensive and unreliable supplies. Second, groundwater resources rely on rainfall for renewal and are strongly affected by climate variability and climate change. Over abstraction of water, which can lead to falling water levels and the exhaustion of resources, is a growing global problem, exacerbated by climate change, population growth, and urbanization (Paul, MacDonald , Carter, 2010)..

Finally, ground water sources across the globe are increasingly being polluted through intensive agriculture, industry, and poor sanitation. For wealthy countries, this increases the costs of providing access to safe water, because more extensive water treatment is required. In poor countries, expensive water treatment is not affordable and there is little option but to drink increasingly contaminated water. **To improve water supply, it is important to tackle issue to water management and protection of water sources. That is true for developing country, including South Sudan** (Paul, MacDonald , Carter, 2010).

**Management of Water Supply Technology**

One of the myths of community water supply in rural areas of low-income countries is that users benefiting from access to modern technology will, after a short period of training, manage the system themselves. The reality is that years of external support may be needed to build the necessary capacity. Without ongoing external support (which is often absent in the context of weak local government), communities often fail to effectively manage modern technology for more than a few years (Paul, MacDonald , Carter, 2010).

Ever since Schumacher’s seminal work promoting the idea of ‘‘intermediate technology,’’ individuals and organisations engaged in poverty alleviation have struggled to define what is now called ‘‘appropriate technology’’. The key is the match, or ‘‘fit,’’ between the technology, the users, and those who have to manage and maintain it. Whether we are dealing with a rural water supply system managed mainly by the user community, or a more technically sophisticated urban supply system, this fit is essential. Modern technologies are only manageable if the right skills, resources, and incentives exist, and if appropriate support structures are provided (Paul, MacDonald , Carter, 2010).

**Finance**

The level of water sector financing in low-income countries is widely criticised as being inadequate, but at the same time water supply budgets are often under utilised or ineffectively used. Delays in the release of central government funds to local authorities combine with inadequate allocations for operational expenses to render local governments ineffective in disbursing the funds that do reach them. Importantly, though, the additional US$11.3 billion that is needed annually to meet the water and sanitation MDG targets—a relatively small investment (a few dollars per capita per year) that is ‘‘highly feasible and within the reach of most nations’’—would yield an estimated seven-fold return (Paul, MacDonald , Carter, 2010).

Improved water supplies (in JMP terminology) usually attract a tariff or water charge. In low-income countries it is common for such tariffs to be set at levels that are below the real running costs. In such cases a vicious circle often becomes established, in which below-cost tariffs lead to inadequate investment in maintenance, which results in deteriorating service and further unwillingness to pay even low tariffs (Paul, MacDonald , Carter, 2010).

Water consumers without an improved water supply do not pay a financial tariff for water. Even though they may pay heavily in terms of health, time, and energy, it often proves extremely difficult to change the mindset of consumers who are used to water being ‘‘free.’’ Even small water charges are not welcomed by consumers, and revenue collections that start as regular monthly charges often deteriorate to ad hoc collections or disappear altogether. Financial irregularities also often militate against continued payment of charges (Paul, MacDonald , Carter, 2010).

**Strategies to Achieve an Improved Water Supply**

Access to a safe and continuous supply of water for drinking, cooking, and personal hygiene is an essential prerequisite for health. An inadequate water supply—whether as a result of poor access or quality, low reliability, high cost, or difficulty of management—is associated with significant health risks. These health risks are experienced most strongly by the poorest nations, and the poorest households within nations. A good water supply is necessary for good sanitation and hygiene, and to underpin livelihoods, nutrition, and economic growth (Paul, MacDonald , Carter, 2010).

The global MDG target on water supply is likely to be met [6] but will leave many hundreds of millions of people without an adequate water supply. Furthermore, the targets are highly unlikely to be met in sub-Saharan Africa. Failure to extend water supply services at an adequate pace is largely a consequence of high population growth rates in the low-income countries, insufficient investment (although the sums needed are not large), and poor governance. Failure of existing water supplies is often due to weak financial and management arrangements for operation and maintenance, and a mismatch between the technology, the water environment, and the capacity of users to maintain systems. The result is poorly performing or broken down urban and rural water supply systems, and continuing poor health (Paul, MacDonald , Carter, 2010).

While the health systems of developing countries are not directly responsible for changing this situation, poor water supplies place large burdens of disease on their populations, and it is those populations and their national health services that pick up the costs of diarrhoea and other diseases. Health professionals should therefore join those from other sectors (infrastructure, education, and economic development) in demanding change. However, it is clear that many uncertainties remain about how to improve public health through improvements in the water supply. Thus, more and better research is desperately needed, in particular larger and longer double-blinded randomized controlled studies of the health impacts of water supply and quality interventions at the community and household level (Paul, MacDonald , Carter, 2010).

But it is equally clear that action must not wait for the outcomes of such research. We know enough now about the importance of improved water supply, sanitation, and hygiene in relation to health to consider universal access to these services to be an urgent imperative (Paul, MacDonald , Carter, 2010).

In order to reverse this trend of water resources depletion and erratic climatic variations, there is need to put in place: Adequate investment in capacity building of WSS and Water Resources managers (Paul, MacDonald , Carter, 2010).

**Effective management of water catchment areas.**

Construction of dams and pans, and initiate groundwater recharge to increase water storage capacities,

Measures to curb water pollution by ensuring adherence to all waste water treatment standards before disposal into the water bodies,

Embrace IWRM principles in efficient use of existing water resources including recycling and reuse of wastewater, Judicious and rational apportionment of water resources thereby avoiding water use conflicts (Paul, MacDonald , Carter, 2010).

Improve the efficiency of water management and consumption ¾Increase capitation for development and conservation of water resources and environment ¾Augment the existing sources of water with more sustainable alternatives: ™ Rainwater harvesting and construction of storage infrastructure ™Ground water recharge ™Water recycling and wastewater reuse for:

* Agriculture
* Industry
* Household use
* Urban landscaping (Paul, MacDonald , Carter, 2010).

**6.What are the key factors to be considered when planning a new landfill in small and medium-sized towns? List at least four factors.**

**Introduction**

Landfill was defined in Study Session 1 as an area of land set aside for the final disposal of solid waste. Ideally the site is managed to prevent people and animals from entering and the deposited waste is covered with soil to isolate it from the environment. However many informal sites do not cover the waste or have any other control measures. We are using ‘landfill’ here as a general term that applies to any site where solid waste is deposited for final disposal.

There are many different types of landfill, some with greater environmental impact than others. In all of them the waste gradually decomposes by a combination of biological, chemical and physical processes. During these decomposition processes, two major emissions are of primary concern – leachate and landfill gas:

* Leachate is the polluted water that emerges at the base of the landfilled waste. It is formed in two ways. Rainwater landing on the waste slowly flows over and through the waste and soluble substances are dissolved in the water. Also, some of the decomposition reactions taking place in the waste produce liquid that can be acidic. Some substances, such as toxic metals, tend to dissolve more easily in acids, making the final leachate more harmful. If leachate enters a watercourse used to provide human or animal drinking water or for irrigation, people can be exposed to these pollutants.
* Landfill gas is formed in large landfills through degradation of the waste in anaerobic conditions. Landfill gas consists of a mixture of carbon dioxide and methane, which are both greenhouse gases that contribute to global climate change. It is also flammable and will burn if exposed to a flame or other source of ignition. In extreme cases, the gas can build up in a landfill and explode, with the risk of injury and death. Managed landfill sites have vent pipes that allow the gas to get out of the waste and be released to the air or burned in a controlled way.

The different types of landfill can be ranked according to their potential to cause environmental pollution. Starting with the worst, they are:

1. Indiscriminate waste disposal
2. Communal open dumping
3. Burial in pits
4. Controlled landfill
5. Sanitary landfill.

**Key factors to be considered when planning a new landfill in small and medium-sized towns? List at least four factors.**

If small and medium-sized towns wish to reduce open dumping, a dedicated controlled landfill site needs to be identified and developed. To plan for a new site, two key factors to consider are the area of land required and the choice of the best location.

**1  Estimation of the required land area**

The first stage is to estimate the volume of space that this waste will occupy.

1. **Finding a suitable location**

Once the area of land is known, the next step would be to find a suitable location. The main factors in deciding if a site is suitable are as follows:

* How far is the site from the centre of the population? On the one hand, if the site is too close, the people may be bothered by odours. However, if the site is more than about 3 km from the town, a transfer station will be needed to transfer the waste from the collection vehicles to a lorry that then takes the waste to the site.
* Is the site near a watercourse? Generally speaking it is better to avoid an area close to flowing water because there is always a risk that leachate will leak from the site. It may be tempting to use a dry valley but this may not be dry during the rainy season and running water could carry the landfilled waste over a large area. For this reason, valleys are best avoided.
* Is there any groundwater under the site? It is important to take specialist advice about this because of the risk of contamination.
* What is the local soil type? Water and leachate flows through different soils at different speeds. Sandy soils tend to be very permeable and leachate will flow through them quickly and for a long distance. Clay soils tend to be less permeable so leachate travels slowly and for shorter distances through them.
* What do the local community think about it? Some areas of land are considered to be sacred by one or more religious groups and should never be considered for landfill. Using such land would be deeply offensive to the people concerned.

1. **Thermal processing methods**

Thermal processing of waste means heating waste so that it burns. During the burning (also known as combustion) process, the combustible material is converted into gases (mainly carbon dioxide and water vapour) and an ash residue. Thermal processing leads to a large reduction in the volume of solid material left over for landfill disposal and destroys pathogens, so it may look like an attractive option. However, unless the combustion takes place under tightly controlled conditions using equipment designed to prevent and capture any pollutants produced, the process will emit a large amount of smoke and other invisible air pollutants that can cause serious health problems.

There are two main thermal processes you may come across: open burning; and incineration. There are other more advanced thermal processing methods but these are not currently used in Ethiopia.

**b) Explain how incineration differs from open burning**

**Open burning**

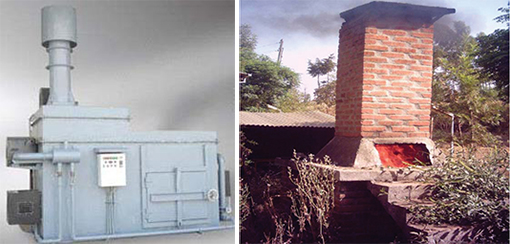
Many individual householders practise **open burning** in their yards, where waste is burned in a pile in the open air and the remaining ash is buried or spread on the ground. This may be easier for the householder than taking their waste to a collection point or a landfill, but the smoke is an annoyance to the neighbours and can be a health hazard (Figure 10.4). You should always discourage open burning unless it really is the only option for dealing with the waste.



*Figure 10.4 Open burning produces a lot of smoke and can be dangerous.*

**Incineration**

**Incineration**, as opposed to open burning, is the combustion of waste material in an enclosed container with an air supply and ideally fitted with a chimney. The combustion process can be controlled to some extent so less pollution is produced and a chimney helps to reduce the impact by sending product gases upwards into the atmosphere. An incinerator of the type that may be used in large schools or hospitals is shown in Figure 10.5(a). Smaller, lower-cost incinerators may be built from bricks (Figure 10.5(b)). These can be built locally and are the type you are most likely to see.



*Figure 10.5  (a) A metal incinerator with a chimney. (b) A brick incinerator is simpler and cheaper to build.*

Incinerators are mostly used in Ethiopia to treat healthcare waste or waste in other institutions such as schools. They are preferable to open burning but they still generate smoke and other pollutants. They need to be operated with care to make sure they function correctly and to minimise possible pollution. Good practices in managing small incinerators include the following:

* Make sure there is a sufficient air supply to the container where the burning takes place. Usually the air flows upwards through the chamber, so the bars that the burning waste sits on should not be blocked.
* Most pollution is formed when the incinerator is heating up, so use firewood or clean, dry waste at the start.
* Waste should be added to the incinerator regularly so that the temperature does not fall and cause smoke to be formed. Generally, wet waste should be added in small amounts and ideally mixed with dry waste.
* The ash should be removed when cold and then buried. Care must be taken to avoid light ash blowing away in the wind.
* The incinerator should be in a fenced-off area – when operating, the external surfaces will become very hot.
* The incinerator operators should be trained adequately. They should wear protective clothing (gloves, face masks, etc.), especially when burning healthcare waste. They should have access to and use handwashing facilities at the end of each shift and before meal breaks.

**7. List and briefly describe the measures by which the success or otherwise of a public–private partnership providing water supply services can be assessed.**

**1.0 Introduction**

Public Private Partnerships, or its commonly used abbreviation “PPP” has become an important way of implementing public tasks and providing public services around the globe. In many countries it has been established as an alternative to conventional procurement methods. In some countries it has already, or according to political priorities, will have in the near future a portion of up to 15% (Germany) or even 20% (UK) of all public procurement. However, it is still a very heterogeneous and unspecific term in practice, as well as in scientific literature it stands for a multitude of different approaches with mostly very complex and sometimes intransparent structures, which is based on the cooperation between public and private actors/players. Consequently, there is often great confusion in international discussions between the different stakeholders like politicians, project executing agencies, private investors, auditing authorities etc. simply because they all may use the term PPP, although they have a very different understanding of it. One essential reason for this, is that if they are compared internationally the historical development of PPP, the understanding of what PPP actually is and what its goals and fields of application are, show very different patterns (Alfen, 2015).

**1.2 Historical development and fields of application of PPP**

The term “PPP” was first used in the USA in the 1960s to refer to typical urban development projects involving private investors. From here, the concept spread all over the world and is still applied in many countries today. Larger cities in particular seek to ensure the involvement and assistance of private investors in order to develop brownfield and fallow sites for use that adequately reflects the aims of urban planning while offering a commercial interest for the investors. The city generally provides the land on which the private partner uses its capital to develop, construct and market the real estate and the corresponding infrastructure, taking into account the relevant urban planning standards and other public requirements but applying its own ideas and at its own risk. The partnership is formed with the goal of a joint concept of urban development and once the goal is reached usually the public partner withdraws and leaves the business to the private partner (Alfen, 2015).

PPPs then became known globally as a method of procurement for the public sector, for example in the area of social and economic infrastructure management. Initially developed into a standardised form as a result of the Private Finance Initiative (PFI) in the United Kingdom in the 1990s, it was taken up throughout the world in various forms and is becoming increasingly popular both as an alternative procurement option for the public sector and a good investment opportunity for private investors. The key characteristic of this kind of PPP is the transfer to private bidders for a limited period of time of integrated services relating for example to the planning, construction, financing, maintenance and operation in a lifecycle approach of public infrastructure, this was previously performed by the public sector. PPPs of this kind also exist in other areas of procurement such as EGovernment and/or IT, procurement of equipment, service vehicles, aeroplanes/helicopters etc (Alfen, 2015).

Besides urban development and public infrastructure management, the term PPP is being used more and more in many varying fields, for example research cooperation, sponsoring (in the areas of sports, education and training), the collaboration of Governments and NGOs and even in charity (Alfen, 2015).

In Germany for example, PPP has been applied for a long time in nearly all of the fields mentioned above. However, there is hardly a harmonised understanding, the goals, the approaches, the concepts, as well as the standards and instruments vary significantly. The only common ground seems to be the collaboration between partners related to the public on the one hand and to the private on the other hand and - after more thorough observation – some inherent structural elements (Alfen, 2015).

Water is a need for all the living organs: no water, no life. Water supply services are important part of humans’ lives and in high income countries people are used to having daily, easy access to clean water through a water tap. It is a startling matter when one begins to wonder what it means to have direct access to water source, since it is not reality for all the people in the world (Raunio, 2015).

According to WHO, in year 2014 700 million people did not have access to clean water resource, and these people were all in developing areas. The population growth and a growing need for water makes providing pure water more challenging. Water flows unequally in nature and some areas are naturally drier, but some areas face lack of water because of the economic situation (Raunio, 2015).

Poverty, climate change, educational inequality and agricultural issues also affect the water supply. To overcome these challenges poor states must develop ways to build water services. Shiva (2002) argues that the water business is a tempting idea for multinational corporations; already in the beginning of 2000 century the World Bank estimated that the potential value of the water market would be over $1 trillion. The value of this market is increasing when the competition on clean water resources is accelerating and population keeps on growing. However, privatisation is not the only option for securing water services in a state (Raunio, 2015).

Public and private actors may work together as partners. This can be seen as a better option than pure privatisation, since most of the partnership types retain part- or whole ownership by the state and it is possible to build the projects in a way that the locals are included in the process. In ideal situations PPPs work in a way they were meant to: to succeed in helping poor states to provide to their citizens water or other scarce resources, such as electricity. The efficiency and success of the project is dependent on many aspects, including acceptance and participation of the local population (Raunio, 2015).

Public-private partnerships hold a lot of potential, and the effect of these in certain areas is huge, but they also hold risks and possibilities for failures. The idea behind this research is to scan and reveal the possibilities and risks behind these kinds of partnerships. The main focus is on the area of Sub-Saharan Africa, since based on the research it is mainly water scarce area because of economic situation and many states use PPPs to provide services to citizens. The topic of water supply is important because at the moment water supply is on an unstable basis and unclean water is a global safety risk; for example, the National Ground Water Association (2015) ranked water as a first global risk last year. The idea of this research is to gather information about PPPs and examine successful ways to implement them to local communities (Raunio, 2015).

**2. Water**

Drinkable water is a limited natural resource; 97,5 % of all the water on Earth is salty ocean water, (UNESCO, 1996) which means that only 2,5% is fresh water, such as ground water, lakes and rivers. This would be enough to distribute clean water for everyone’s needs, but water flows unequally in nature and new challenges such as climate change are affecting the situation. Approximately two-thirds of all fresh water is frozen in ice sheets and glaciers. (Green Facts, 2015)

In 2014 the WHO made a report about water facilities in the world and the results were as follows; 2,5 billion people do not have access to improved sanitation and 700 million people do not have access to drinking water. The continuing conflicts, decrease of clean water level and unequal distribution of water are affecting to poverty rates and quality of life. United Nation’s General Comment number 15: The Right to Waters describes legal bases for water for every human in the world. The second paragraph of the comment begins with a statement:

“The human right to water entitles everyone to sufficient, safe acceptable, physically accessible and affordable water for personal and domestic uses.” UN Committee on Economic, Social and Cultural Rights (CESCR) (2003).

UN defines water as a human right. (UN Committee on Economic, Social and Cultural Rights (CESCR), General Comment No. 15, 2003) However, the comment does not define how this right should be applied in practice and who is responsible for doing so (Raunio, 2015).

The United Nations Development Programme (here and afterwards abbreviated as UNDP) (2006) published the guidelines of the meaning behind this specifically. According UNDP (2006) to every person should have a satisfactory and permanent water supply for personal and domestic needs and the quality of this water should be good; it should not cause any diseases, it should smell, look and taste as clean water does. It should also be physically near; according the WHO the source of water should be within 1,000 metres from home and 30 minutes should be the maximum amount of time used to collect it. UNDP also suggests that water costs should not be more than 3 % of the household incomes. However, this human right is only a human right of a few; lack of clean water and sanitation causes millions of deaths in a year, mainly in poor, developing countries. The problem of unclean water is influencing the whole world (Raunio, 2015) .

* 1. **Water distribution**

According to Seckler et al. (1998), water exists in four different sources, which form the global water balance. Water distribution is explained in this chapter and it is based on the work of Seckler et al (ibid) unless otherwise mentioned. Water inflow from rivers and aquifers minus outflows is the net flow of water. However, this flow can be disturbed and it may change because of inter annual changes that affect to snow and ice glaciers, lakes, aquifers and soll-moisture. This change is called as changes in storage. The changes affect the sustainability of a water source, both negatively and positively, since in some cases it means that new water sources are born annually (Raunio, 2015).

Runoff means the surface and subsurface flow of water. Runoff is almost impossible to measure directly on a large scale because of water recycling. Desalinization means water produced from seawater or brackish water but it is a limited and expensive source. All these four form the Annual Water Resources (here and afterward abbreviated as AWR) of a country (Raunio, 2015).

It is important to notice that AWR only forms from above sources on a sustainable basis, which is why for example the depletion of aquifers is not considered part of it. The potential utilizable water resource (here and afterwards abbreviated as PUWR) is the amount of AWR that is potentially utilizable with socially, environmentally, economically and technically feasible water development programs. Many countries have not developed their PUWR, which means that part of it goes directly to the outflows. When defining a country’s PUWR, it is important to consider the reliability of the annual water source. The developed water re source (here and afterwards abbreviated as DWR) is the part of PUWR that is controlled and it becomes the first or primary water resource to the supply system. DWR is almost impossible to measure, because it often comes from multiple sources, with an exception of few countries, like Egypt, where all of DWR comes from one source, High Aswan Dam (Raunio, 2015).

The DWR feeds into the effective water supply (here and afterwards abbreviated as EWS). The EWS leads on to the distribution system, which is divided into sectors that are important for understanding the issue of water scarcity. The other source of EWS is the return flow, water used by these sectors. The main sectors that use water sources are agriculture, domestic, industrial and environmental sectors (Raunio, 2015).

If water distribution can be defined as in figure 2, based the study of Seckler et al. (1998), one may wonder how is water actually seen in relation to other resources or society’s every day needs. To understand the ways of producing water services one must define is water as a pure public or private good, or something more complex. Often goods can be defined as public or private, but with water the answer is not that simple. (Kaul, Grunberg and Stern 1999) In the following chapters public and private aspects in the issue of water will be examined (Raunio, 2015).

* 1. **Water as a good**

As Raunio (2015) defines in her study about PPPs, in areas that suffer from water scarcity the states are often poor and cannot produce water services to the citizens or to the needs of industries or agriculture. This makes the issue of water supply services politically delicate and important to the states, but also problematic from a financial point of view. This means that these states need to involve either public organisations or private entities when producing water services. The private sector has been involved to water and sanitation projects in the Global South since the 1990’s, according to Budds and McGranahan (2003).

The UN conference in Dublin 1992 about water and sustainable development published four principles about sustainability and water use, and the last one of the principles was stated as followed:

“Principle No. 4 – Water has an economic value in all its competing uses and should be recognized as an economic good”

The idea behind this statement was that societies’ earlier use of water has often been wasteful and damaging, and if the water is seen as having an economic value, it is possible to achieve efficient and equitable use, as well as to encourage conservation and protection of water resources. (WMO, Dublin statement on water and sustainable development, 1992).

When a subject has a high public agenda, but demands participation of private sector actors, conflicts are likely to occur since the private sector pursues profit whereas the public benefit rarely is profitable, as Raunio (2015) defines in her research. The on-going debate about public versus private or these two operating together often attracts high attention towards the participation of private sector, but it may detract the attention from actual challenges, actual scarcity of water and obscure the roles private enterprises can play in water and sanitation projects, as Budds and McGranahan (2013) argue.

Budds and McGranahan (ibid) explain in their research that usually areas that are not served with water pipes or clean water are small, low-income towns and villages, in the rural areas of developing countries, towards which large international companies have shown only a little interest. This is understandable given the goals of private enterprises. In this kind of place a third party, and international or local organisation, plays an important role (Raunio, 2015).

Raunio (2015) argues that when a private sector actor is included in a water project, it often polarizes the conversation in the area, especially when the prices of water are rising. The situation is absurd since the private sector has come to solve the problem of water supply, but because in these places demand is higher than supply, the prices are rising. This makes the situation unbearable for citizens who suffer from poverty and might force them to build illegal connections to water pipes as presented in case study from South Africa, presented in chapter 7.2. Budds and McGranahan (2013) stress the fact that under the right circumstances the private sector can and often does improve the efficiency of water supply and increases the funding of the project (Raunio, 2015).

As Budds and McGranahan (ibid) argue, the private sector is strongly encouraged to act in the Global South by international financial players. However, Rugemalila and Gibbs (2013) argue that so far the results has been rather disappointing. However, Pawar (2014) states that the public sector cannot alone supply enough water for the demand, since the challenge of demand exceeding the supply in water sector is real (Raunio, 2015).

According to Lewis (2016), the rapid population growth in urban areas, especially in SubSaharan Africa, has led to a situation where existing water sources have dried up, or to polluting the water sources with, for example, human waste. This means that water sources need to be rebuilt and brought to the locals, which in poor states might be difficult to do without help from private sector. However, this does not mean that water would be purely private or even purely public good, as Perry, Rock and Seckler (1997) argue; the issue of water being private or public good is a question of values (Raunio, 2015).

* 1. **Public goods**

Kaul, Grunberg and Stern (1999) describe in their book Global Public Goods the aspects of public goods. According to them a term ‘public good’ means goods with features of nonrivalry and non-excludability; the goods are impossible to produce in competitive markets and it should not be possible to prevent people for using them. Pure public goods are very rare but they have both these qualities. Kaul, Grunberg and Stern (ibid) argue that public goods cannot be produced in economic markets; these goods are something everyone can enjoy; for example, clean environment would be this kind of good (Raunio, 2015).

Most goods are impure public or private goods, since pure private goods are as rare as pure public goods. As Kaul, Grunberg and Stern (ibid) define it, impure public goods are something affecting both private market and public wealth; for example it could be a healthy meal. A healthy meal may seem to be a private good since a consumer purchases it in exchange for money, but a healthy meal also affects positively to the consumer’s health, which again compensates in higher productivity and less costs for society. Impure public goods create positive externalities for society (Raunio, 2015).

As this research is about producing water supply services in water scarce areas, it is important to understand the relevance of water as a good; both for consumers and for the markets. By the definition given in the chapters above, water is an impure public good, which also could be described as a private good with high public benefits, since water has significant public benefits but in many areas consumers use it in exchange for money. However, the water purchased should be clean. According to Budds and McGranahan (2013) clean water not only affects positively consumers’ health, but also makes the society cleaner and safer, as well as offering protection from infectious diseases. This means that providing clean water for consumers is beneficial to both public and private sectors (Raunio, 2015).

* + 1. **Private goods**

The description of water being an impure public good means that part of it, or even the whole supply chain of clean water is a private good or supplementing a private good. Kaul, 11 Grungerg and Stern (1999) explain private goods in relation to money, since those are products or services traded in exchange for money, or sometimes in an exchange to another good. As Perry, Rock and Seckler (1997) argue, a private good could be determined by the overriding value of consumer sovereignty. However, this description completely ignores the distribution of income in society as well as the effect of positive externalities (Raunio, 2015).

In a welfare state an economic system provides services and goods for citizens but in areas fighting to overcome poverty, the provision of services and goods is more complicated. In poor states citizens often lack the resources to purchase basic goods and services, such as food or clothes. This correlates with higher need for basic goods in these areas. As Kaul, Grunberg and Stern (1999) explain global inequality, the gap between rich and poor, makes already basic, everyday goods as luxury products in poor areas (Raunio, 2015).

In welfare states water might be seen as a good purchased in exchange for money, but it is challenging to explain this to citizens in poor areas. These poor areas are also areas where poor people live in high-income countries accustomed to municipal provision, and water is a good paid for via taxation. The lack of wealth is not the only challenge when describing water as a private good, Kaul, Grunberg and Stern (ibid) argue. Private goods are simple to purchase and sell when the owner is known, but with a product that comes from natural resources and flows unequally in different areas and states, the ownership is difficult to define. Based on their research, turning water into a purchasable, the private good aspect is problematic since the ownership and rights to water are conflicting. In this question one must remember that pricing this kind of good is also unclear, especially when people do not have wealth to purchase many products necessary to ensure life (Raunio, 2015).

Perry, Rock and Seckler (1997) argue that if water is seen as a good with both public and economic value, one needs to remember the difference between the “economic value” and “financial value”. These two values rarely correspond but in the issue of water, the distinction is particularly important, since its economic value is significant, but the financial value is impossible to define in a universal way. However, Perry, Rock and Seckler (ibid) believe that privatizing water would give greater possibilities to farmers, consumers and markets to affect the pricing of water (Raunio, 2015).

Public-private partnerships As stated in the research made by Raunio (2015), PPPs are increasing both in developing and developed countries as they provide citizens basic services, such as water, energy, and transportation services. However, lately PPPs have also been used in IT services, hospitals, schools, military services, and other areas. According to Raunio (ibid), in general the name PPP refers to agreements between the state and a private entity, which come together to make a contract and plan to provide services. The goal is to meet growing demand for goods that have high public benefits, like water. Tanzania’s Prime Minister’s Offices policy report for PPPs (2009) p.1, reminds that in PPPs the private entity often assumes the risks for significant time period and in return benefits financially by receiving tariffs or user charges. Many different ways to build these partnerships exists, many different types of contracts are used depending on the concept, width and length of a project, as well as the specific need of a certain area, its citizens and the partners. However, PPPs are not the same as pure privatisation of public assets (Raunio, 2015).

According to Marin (2009) p.1-7, the growth in water PPPs began between 1991 and 2000. Already during that time the population served by private actors in developing countries grew from 6 million to 94 million and the number of active water PPP projects increased from 4 to 38. However, according to Marin (ibid) the lack of data on the populations successfully served by water PPPs and on the quality of services provided has made the objective assessment of these PPPs difficult. Since the matter is sensitive and ideological, the debate about the projects often becomes polarized, which has led to challenges in setting up new projects and especially SSA is a challenging region to reform (Raunio, 2015).

However, according to Kirkpatrick, Parker and Zhang (2006) the donors such as WB create pressure for developing countries to try privatisation when building utilities. This is a critical issue when considering building PPPs, especially when objective or empirical analysis are not well examined in the materials of WB, African Development Bank (AfDB), UN or other international organisations. Empirical analyses are more likely to be found from independent researchers who have been working in the field or studying matter from universities. Kirkpatrick, Parker and Zhang (ibid) have made an empirical analysis of providing water services in Africa where they compare privatisation and state owned utilities. Their research failed to find any evidence that private utility would perform better than state-owned utility. Hall and Lobina (2005) argue that surprisingly International Monetary Fund (IMF) stated that it cannot be taken for granted that PPPs would be more effective than public investment and government supply of services. However, these kinds of statements from international organisations are challenging to find, when they usually try to stay neutral about the matter or encourage for private investments (Raunio, 2015).

Marin (ibid) claims that between 1990 and 2009, more than 24 million people in developing countries have gained access to piped water. When PPP succeeds, the quality of water service is improved, especially by reducing water rationing. In PPPs one of the important factors when choosing the private operators is the efficiency of the operator. In water PPPs the effectiveness can be broadly measured in three main ways; water losses, labour productivity and bill collection (Raunio, 2015).

Marin (2009) argues that water PPPs are a viable option in developing countries, despite limitations and some failed projects; according to him the water PPPs have been satisfactory when measuring the overall performance. However, some other researchers disagree with Marin and describe possible flaws and problems with these agreements. For instance Kirkpatrick, Clarke, and Polidano (2002) describe in their research some of the disadvantages of these partnerships. They point out that even though the intention of an action in partnerships is good, these partnerships may displace public workforce in the area of partnership and are then causing higher unemployment within locals. According to them, PPPs may turn into a monopoly, because of a lack of competition (Raunio, 2015).

According to Raunio (2015) the challenges to build successful PPPs are sometimes caused because they are dependent on mutual trust between the government, private actors and citizens. However, as Marin (2009) states, several PPPs have managed to provide more effective services with better quality; out of 65 developing countries that have used water PPPs since 1990’s, at least 41 of those were still using private water entities in 2009. Water PPPs often operate in extreme conditions and physically difficult places, but as stated in chapter 3 about water scarcity and especially economic reasons for the scarcity, many failed PPPs happen in areas where poverty eventually rules out the private operator (Raunio, 2015).

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The PPPs usually differ depending on the region since the definition of “partnership” may confuse locals and even the parties themselves. Budds and McGranahan (2013) refer in their research to the fact that the term does not automatically mean an equal amount of responsibilities and risks for the parties. “PPP” is a widely used term and since a fixed definition does not exist, the contracts are important when deciding who is responsible and who bears the risks for different parts of the project (Raunio, 2015).

According to Kayaga (2008), water and sanitation PPPs are the least common types of PPPs, especially in the SSA region. However, this does not mean that developing countries’ governments would not need assistance in organising water and sanitation supplies, but it is more a sign that the topic is politically delicate. Kayaga (2008) argues that in some developing areas the citizens see water as a gift from God, which is a viewpoint that western nations most likely find difficult to understand, but for these citizens it simply means that water is not a good to be paid for. These issues make implementation of the projects difficult but the involvement of the locals even more important. One solution for this is to use local companies; as Marin (2009) states, local companies understand local culture and people better, which can allow them more easily to establish reasonable partnerships with local authorities and also better minimise the political risks. Local companies might be better at serving small cities than their international competitors (Raunio, 2015).

Hall and Lobina (2013) are critical of water PPPs. They claim that the private sector’s goal to achieve maximum profit is impossible to combine with the need of poor areas. These researchers are not alone with this kind of opinion on the matter; the literature on PPPs is often strongly arguing about the disadvantages of these (Iossa and Martimort, 2013). However, as Raunio (2015) states that the failure of PPP is not necessarily a result of private sector deficiencies, often it is a combination of many reasons. One of the reasons for PPP to fail is poor implementation of the partnership within the local community. However, based on all the research made for this thesis, public sector must consider carefully all the sides of PPPs before entering into a contract (Raunio, 2015).

**2.4 Benefits of PPPs**

Despite the risks in PPPs, they also hold great advantages and benefits for all parties. The following sections present these benefits for each party and are based on the research made by Ndandiko and Ibanda (2010) unless otherwise stated. This chapter is purely based on an assumption that PPP succeeds (Raunio, 2015).

**2.5 Public sector**

The public sector benefits from PPPs several ways. The risk and responsibilities are divided among different entities as well as maintenance and design construction. This affects positively the lifecycle cost management since greater attention towards design and qualitybuilding materials is achieved. This also increases the costs but with a private entity involved, it is beneficial to the public sector. Since the consortium is not paid solely for the construction but also for the service delivery, the construction will most likely be carefully managed (Raunio, 2015).

Involvement of a private entity and the specialists employed by it signifies that more innovative solutions are most likely to be achieved. Local government can engage the private sector’s capacity to innovate and deliver improved value for funding. If a government agrees on sharing its assets or facilities with other users it provides public services with greater economic value, for example by sharing government-owned buildings, materials or intellectual property such as educational materials. If PPP succeeds well, more public resources will be saved than with cooperation with other public entities, which again correlates positively when providing other public services (Raunio, 2015).

**2.6 Private sector**

For the private sector PPPs mean business opportunities and export opportunities. It is very beneficial for a company to be involved in a process from the beginning until the end, to be planning project design, construction, operations and maintenance, not only because the reward will be higher when more work is done, but also because it correlates positively with learning possibilities. If the private entity is a foreign company, the export opportunity will increase the competition of service providers, which will give the best prices to the locals (Raunio, 2015).

**2.7 Wider community**

The partnerships provide opportunity to strengthen bond markets in the state. In PPPs the local government can monitor and regulate the quality of delivery and the compliance with the staff and take care of environmental, financial, legal, commercial and health-related issues with less risk for conflicts, for example by creating jobs. The opportunity for the private entity and the public entity will expand businesses and encourage employment opportunities. PPPs can also adapt locals to the processes and allow them to participate in decision-making processes of the local government (Raunio, 2015).

* 1. **Description of measures by which the success or otherwise of a public–private partnership providing water supply services can be assessed**

The performance of a PPP (and indeed a public water utility) can be assessed through the following parameters (Athena Infonomics, 2012):

* Accessibility: What proportion of the population have access to water? Is the distance to the water point less than 1 km or 30 minutes’ walking time?
* Affordability: Is the cost of the water needed less than 5% of the household’s income?
* Cost recovery: Is the cost of providing the water being recouped?
* Water quality: Is there adherence to national standards?
* Operational efficiency: What is the quantity of water supplied per capita? What is the duration of water supply in hours per day?

These parameters can be used to evaluate whether a PPP is beneficial, with data from before the partnership’s creation being compared with data after the PPP has been running for, say, a year.

**8. What are the possible interventions to manage the solid waste in an emergency situation? Explain at least three actions that could be taken.**

**Introduction**

The safe disposal of solid waste is critical for public health, especially during an emergency. Not only will existing solid waste collection and disposal systems be disrupted but there will be extra waste caused by the emergency itself. Initially at temporary settlements for displaced people or refugees there will be no arrangements in place at all for solid waste management. If solid waste is not dealt with quickly, serious health risks will develop, which may further demoralise the displaced community already traumatised by the emergency.

If organic solid wastes (such as food waste) are not managed properly, there are major risks of fly and rodent infestation (particularly rats) and surface water pollution. Solid waste often blocks drainage channels and leads to environmental health problems associated with stagnant and polluted surface water that can lead to drinking water contamination. Uncollected and accumulating solid waste and the debris left after an emergency, natural disaster or conflict may also create a depressing and ugly environment, discouraging efforts to improve other aspects of environmental health.

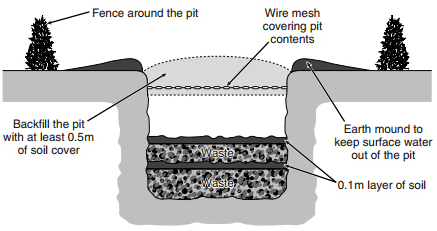
The Sphere standard for solid waste management aims to ensure that ‘the affected population has an environment not littered by solid waste, including medical waste, and has the means to dispose of their domestic waste conveniently and effectively’ (Sphere Project, 2011).The key indicators in the Sphere standards include specific requirements such as ‘all households have access to refuse containers which are emptied twice a week at minimum and are no more than 100 m from a communal refuse pit’.

At a temporary settlement site, routines for the storage, collection and the disposal of solid waste or refuse need to be implemented and resourced. This is particularly important at high density sites. Engaging the community can be a vital aspect and any initial clean-up operation should be community based.

A common way to produce storage containers is to use 200-litre drums that can be cut in half to give two 100-litre drums. Drainage holes should be drilled in the bottom. UNHCR suggest that these drums should be placed throughout the site so that no household is more than 15 m away from one (UNHCR, 2007).

Collection from site containers should be done regularly (daily if possible). Lorry or tractor and trailer-based collections can be expensive. It may be more appropriate to use hand carts, wheelbarrows or donkey-pulled carts if available.

The options for treatment and disposal of solid waste in emergency situations are similar to the standard methods that you learned about in Study Session 10. Open dumping should be avoided because of the health risks for people and animals. Burning of solid waste is possible although it creates the problem of smoke and will not achieve a sufficiently high temperature unless a purpose-built incinerator is used. The most likely disposal method is burial. If it is possible to do so, existing waste disposal sites should continue to be used. For temporary settlements, areas should be designated for burying waste and they should be well away from households and fenced off. If waste is to be buried on-site in either household or communal pits, it should be covered daily with a thin layer of earth to prevent it attracting vectors such as flies and rodents. Figure 14.4 shows the main features of a solid waste burial pit.



*Figure 14.4 Solid waste burial pit. (Davis and Lambert, 2002)*

**Disposal of human bodies**

It is an unpleasant fact that in some disaster situations people may lose their lives. In the worst cases, this may result in many bodies needing to be disposed of quickly, safely and respectfully. This is inevitably very distressing for everyone concerned. The WHO Technical Note (WHO/WEDC, 2013b) includes the following recommendations:

* Bodies should be collected as quickly as possible, but without interrupting other activities aimed at helping survivors. Bodies should be placed in body bags and labelled with a unique reference number. If body bags are not available, plastic sheets, shrouds or other locally available materials should be used.
* Although collection of bodies should be done quickly, it is not necessary or advisable to hurry their disposal. It is important for bodies to be identified and relatives to be informed and allowed to make their own decisions about the next steps.
* If possible, bodies should be stored under refrigeration but if this is not available, then temporary burial is the next best option.
* The recovery teams who are collecting bodies may be made up of members of the surviving community, volunteers and specialist search and rescue teams. Recovery teams should wear protective equipment such as gloves and boots. They should also be encouraged to wash their hands with soap after handling dead bodies.

The people involved in body recovery and other aspects of dealing with the immediate problems of an emergency may need to be protected from other hazards. Depending on the type of emergency, there may be danger of physical injury, for example, from collapsing buildings. There are obvious health risks in the case of outbreaks of infectious disease which may need specialist protective clothing. There are also potential impacts on the mental health of survivors and recovery team members which may not become apparent until well after the event. Appropriate medical treatment and care should be available to all those affected by an emergency to ensure long-term recovery.

* 1. **What are the most important questions you would need to address in a rapid assessment of an emergency?**

1. **Why Conduct a Rapid Assessment?**

A rapid assessment is conducted immediately after the onset of a disaster in order to locally assess the disaster-affected areas and the needs of disaster victims. As medical providers, when one is faced with catastrophic disasters such as the Great East Japan Earthquake, the first urge is to immediately go and provide assistance. However, one must fight that initial impulse, and first conduct an initial rapid assessment. This is separate from immediate lifesaving activities of the emergency search and rescue teams or disaster medical assistance teams. As indicated in the Sphere Standards, the first step in humanitarian response is to assess the needs of the affected population, and design a prioritized plan of action based on those needs. By doing so, this improves the quality and speed of response. Without a rapid assessment, significant gaps or overlaps in assistance may occur, which not only wastes precious resources at a time of great need, but can also be a cause of further burden to the affected population (Open, 2018).

The initial rapid assessment is conducted as early as a few hours after the onset of a disaster, and should be completed within 3 days at the latest. The purpose of this assessment is not to conduct a detailed survey, but to perform a broad assessment of the disaster and basic needs of the population in order to identify priorities for assistance. When performing the assessment, it is advised to collect information from as many sources as possible, and to perform direct obser vation in order to verify the data. Due to time, resource, and/or security constraints, one is often forced to rely on reports from different sources. However, when one relies too much on secondary information, significant gaps can be missed. For example, a local public health center may report that 20 latrines have been distributed, but upon direct observation, one may find that they were all out of use. This is why it is important to perform direct observation and confirm with one’s own eyes as much as possible. There are other limitations of the initial rapid assessment that responders need to keep in mind, and these are discussed in a later section (Open, 2018).

1. **What Information Needs to Be Collected During a Rapid Assessment?**

The checklist for a rapid assessment is shown in Table 1, which includes access and security, demographics of the affected population, community resources, health, water, sanitation, food and non-food items, and shelters (including temporary housing). In the past, the United Nations and various NGOs have prepared their own rapid assessment forms. Public health specialists with expertise in humanitarian response at Harvard University, Johns Hopkins University, and the American Red Cross also prepared a rapid assessment form when responding to Hurricane Katrina. Shown in Fig. 1 is the rapid assessment form that was modified specifically for use in Japan (Open, 2018).

The first section on the form, access and security, assesses how safely disaster relief teams can access the affected areas. This includes accessibility and safety of roads as well as the risk of secondary damage from chemicals and fires, and the connectivity of phones and the internet (Open, 2018).

|  |
| --- |
| 1. **Security and Access** • Route(s) to the location • Damage severity • Road accessibility, building collapse • Secondary disaster: chemical disaster, fire • Pipeline damage: gas, water, sewerage • Ongoing safety and security concerns • Weather conditions • Phone/internet connectivity  **2. Population Affected** • Population before disaster • Number of populations displaced • Estimated sex ratio • Age profile: children under 5 years of age • Vulnerable groups with special needs - Dialysis patients, oxygen-dependent patients, immobile elderly, unaccompanied minors, pregnant women, etc.  **3. Community resources** • Community disaster infrastructure - Emergency warning system - Community disaster plan and drills - Pre-designated shelters • Means of transportation • Means of communication - Mobile phones, landlines, internet, television, radio  **4 to 7. Mortality and Health Impact** • Mortality (crude mortality rate, under 5 mortality rate) • Main diseases and morbidity • Damage and impact to medical facilities, staff, and supplies • Public health infrastructure (surveillance, immunization) • Damage to emergency medical services • Child health  • Reproductive health (emergency obstetric care, prevention of sexual violence)  **8. Water** • Water source • Water distribution system • Water storage • Distance from homes to water source • Water testing system  **9. Sanitation** • Toilet facilities - Types - Number - Location (distance from shelter/housing) - Lights, locks - Maintenance - Menstrual hygiene materials • Sanitation - Lavatories, buckets, warm water, shower - Privacy in bathing/washing space  **10. Food and Non-food** items • Food supply and calorie intake • Cooking (self-preparation, communal kitchen) • Food sources, staples, and food storage methods • Essential items for daily living - Water containers, blankets, bedding/mattresses, soaps, cooking tools and equipment (e.g., utensils, stoves, etc.), lighting, heating/air-conditioning equipment - Electricity, gas, and gasoline supplies  **11. Shelter (including temporary housing)** • Status and need for temporary shelters • Number of shelters and each capacity • Covered area • Availability of partitions (family-based or for different sex) |

The second section is demographics of the affected population. This includes the total population affected, number of displaced population as well as gender breakdown and the number of children under the age of 5. The size of vulnerable populations such as unaccompanied minors, pregnant women, immobile elderly, and dialysis or oxygen dependent population is also included in this section. The protection of unaccompanied minors is a major issue especially in developing countries, as they may fall victim to kidnapping and human trafficking, and international agencies such as UNICEF are specifically assigned to account for and protect these children during disasters (Open, 2018).

As for disaster-related community resources, Japan has in place highly functioning disasterresistant infrastructures such as emergency warning systems. However, especially during major disasters, assessing shelters and evacuation plans, as well as transportation and communication infrastructure immediately available to the disaster affected population is a crucial part of the rapid assessment (Open, 2018).

Sections 4 through 7 on the form concerns mortality and impact on the affected population’s health and healthcare infrastructure. The crude mortality rate (deaths/10,000 persons/day) is the most useful health indicator to monitor and evaluate the severity of the disaster. It is vital not only to calculate the crude mortality rate of the entire affected population, but also age-aggregated data for the under 5 population. This is because in general, during humanitarian emergencies, small children are affected more heavily, and the under five mortality rate (deaths/10,000 children under age 5 years/day) is a more sensitive indicator than the crude mortality rate. Both the crude mortality rate and under 5 mortality rate must be aimed to be kept at less than twice the baseline crude mortality rate. Damage to healthcare infrastructure as well as available human resources, equipment, medication, transport and referral system, and volume and types of patients seen at the facilities are assessed through direct observation and communication with healthcare providers (Open, 2018).

Water, sanitation and food and non-food items are assessed separately for each area based on the Sphere Standards. The same approach should also apply when examining situations of shelters (Open, 2018).

**Sources and Methods of Data Collection**

Information gathering starts moments after the onset of the disaster, even before the assessment team leaves to go to the affected areas. While the rapid assessment team is preparing to leave, other staff should be delegated to collect information from reports from first responders, relief workers through ReliefWeb (http://reliefweb.int/) and other means including existing professional networks, as well as the media, and official announcements released by the government. Background data of the affected population is also collected through existing official records, national census, maps, as well as websites such as the CIA World Factbook in cases of international humanitarian response (Open, 2018).

When conducting the rapid assessment in the field, it is important to involve the affected population from the outset. They should be treated not just as receivers of assistance, but a participatory approach must be taken in order to truly understand the needs of the affected population and to design a response that meets those needs. It is also important to collaborate with other relief teams in order to avoid repetitive or redundant activity, and lessen the burden to the affected population. The data obtained from the affected areas needs to be recorded along with the source and contact information, and its contents should be cross-checked as much as possible. Officials at the local city hall, community leaders, public health centers, providers at hospitals, and other responders are important sources of information, and key informant interviews should be conducted with these people. However, these sources may overlook the needs of vulnerable populations such as small children, immobile elderly, and physically or mentally disabled, therefore it is necessary to collect data from various sources as much as possible (Open, 2018).

In addition to key informant interviews, other sources and methods of collecting information include an aerial survey of the affected areas from a helicopter or an airplane, community mapping, or a transect walk conducted by walking straight across the central part of the affected area while making careful observations—watching, listening, asking questions—and taking notes and drawing a cross-section of the visited area along the way. Direct observation is performed, for example, by checking the level of the water tank with one’s own eyes, or observing inside of a temporary shelter. In the process, the evaluator should focus on the following 5 points (Open, 2018).

1. Assess the general layout

2. Estimate the number of affected people and local infrastructures and resources

3. Living conditions, sanitation, water supply, food supply, health and healthcare services, and level of insecurity

4. The degree to which “normal life” and social structure have been disrupted

5. How well the affected population is coping (Open, 2018).

**Limitations and drawbacks of a rapid assessment**

When conducting a rapid assessment, evaluators must understand its limitations and drawbacks. Because speed is a priority, the accuracy of the data may be compromised, and the information obtained is often prone to bias. In addition, certain areas may not have been assessed due to issues of access or security. Lastly, during the rapid assessment, members of the assessment team are often faced with the dilemma of providing care to people in need of medical assistance in the face of needing to complete the assessment as quickly as possible. While it is important to provide information to the affected population on available resources, such as where one can go to receive medical care or shelter, the assessment team should not be focusing on providing direct medical assistance unless it is for a lifethreatening emergency. It is best to have contact information for the DMAT team or local medical providers so that cases can be referred in such situations (Open, 2018).

Table 2 Materials for Rapid Assessment

☐ Food

☐ Water

☐ Fuel

☐ Tents/sleeping bags

☐ Climate appropriate clothing

☐ Compass/GPS unit

☐ Maps (plastic, if available)

☐ List of contacts

☐ Camera

☐ Flashlight

☐ Backpack

☐ Batteries

☐ Chargers/adapters

☐ Communication devices

○ Satellite phone

○ Mobile phone

☐ Data entry supplies

○ iPhone/smartphone+applications

○ Paper

○ Clipboard

○ Note pads

○ Pens/pencils

○ Calculator

○ Stapler

**Things to Consider Before Conducting a Rapid Assessment**

In terms of travel logistics, the following points needs to be kept in mind. The assessment team should consist of disaster experts, staff familiar with the local area, and relevant specialists (public health, epidemiology, logistics, etc.), and it is imperative that they have a full understanding of the Sphere Standards. Before conducting the assessment, it must be decided which teams will cover which areas, and these teams should collaborate to carry out the survey. The survey should be completed within 3 days at the longest. Information on local health concerns, security, safety, and communication infrastructure is also essential from a logistical standpoint (Open, 2018).

**At the End of a Rapid Assessment**

The collected information should be triangulated from different sources as much as possible, and promptly reported to headquarters. When reporting, it is important to consider “what is most important in disaster relief” based on the Sphere Standards and create a prioritized list of recommendations for response, as well as areas in need of more in-depth assessment. It is also important to recognize that the rapid assessment is not meant to be in-depth, and incomplete information is expected due to time and/or security and safety constraints. In addition to reporting back to the organization’s headquarters, the results of the assessment must also be shared with other disaster relief organizations and relevant sections of the local governments to cross check information and to appropriately coordinate the response (Open, 2018).

1. **Filtration and disinfection are important water treatment processes. Briefly describe each of these processes and explain their role in making water safe to drink**

# Filtration

In filtration, the partially treated water is passed through a medium such as sand or anthracite, which acts as a 'strainer', retaining the fine organic and inorganic material and allowing clean water through. The action of filters is complex and in some types of filter biological action also takes place. Sand filters are used in water treatment to remove the fine particles which cannot be economically removed by sedimentation. They have been effective in removing *Cryptosporidium*, a protozoan parasite (Open, 2018).

Mechanical straining of the water is only a minor part of the filtration process, as the main process by which particles are retained is adsorption. In adsorption, the particles adhere to the filter material or previously adsorbed particles. If a particle passes close to a solid surface, there may be either electrical attraction or repulsion, depending on the surface charges of both the particle and the solid surface (Open, 2018).

Filtration in water treatment can be carried out using simple slow sand filters or, as is more usual for flocculated water, rapid gravity sand filters (Open, 2018).

A slow sand filter consists of a shallow basin in which about a metre of sand rests on a gravel base, underneath which there is a system of collection pipes and channels for the filtered water (Figure 28). The water to be treated flows down through the filter bed and, as it does so, a layer a few millimetres thick of algae, plankton and other microscopic plant life forms on the top. This layer is known as the Schmutzdecke, which is German for film or deck of dirt. In this layer, fine filtration takes place. In order to preserve this layer, the temperature and velocity of the inflow must be carefully controlled. Some biodegradation also takes place on the *Schmutzdecke*, resulting in a reduction of the organic matter, nitrate and phosphate which may be present in the water. The flow rate is normally in the range 0.1–0.2 m3 m−2 h−1. This means that a filter of, say, 21 m2 would produce a maximum of 0.2 × 21 = 4.2 m3 of water per hour (Open, 2018).

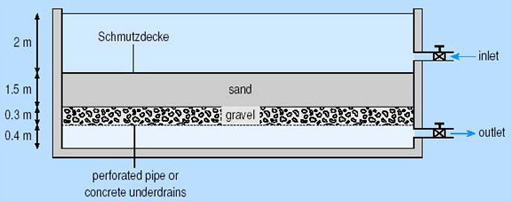


Figure 28 Section through a slow sand filter

When the rate of filtration begins to tail off after a month or two, the filter is drained and the top 2 cm of sand is removed to be replaced by fresh sand. Slow sand filters are expensive to build and operate, and require a large amount of space. They cannot be used for coagulated waters because of rapid clogging (Open, 2018).

Slow sand filters have been largely replaced by rapid gravity sand filters, which are particularly effective for water treated with coagulants and are less expensive than slow sand filters (Figure 29). The flow is much greater than in slow sand filters, being 4–8 m3 m−2 h−1; hence a smaller filter (requiring a smaller space) will be adequate. Because of the high rate of flow, no *Schmutzdecke* is formed and hence little or no biodegradation takes place in these filters. The filter is cleaned at intervals of 24–48 hours by pumping water and air (to assist in scouring) under pressure backwards through the filter to wash out the trapped impurities. This process is called *backwashing*. Unlike slow sand filters which tend to produce water with a particularly low bacterial count, rapid filters produce water with high bacterial counts, increasing the necessity to follow them with disinfection before supplying the water to the public (Open, 2018).

In many treatment plants where slow sand filtration is the key processing stage, rapid gravity filtration is employed prior to the slow sand filter in a process called double sand filtration. In this arrangement, the rapid gravity filters reduce the load of solid matter in the water before it goes to the slow sand filters. This allows a greater overall rate of treatment and the slow sand filters do not then need to be cleaned so often (Open, 2018).

A variation of the filtering process is the use of a layer of large anthracite grains (1.2–2.5 mm) on top of a layer of smaller (0.5–1.0 mm) sand grains, which are denser and have a smaller 'intergrain' pore size. Anthracite-sand filters tend to clog less rapidly because some of the floc adheres to the larger anthracite grains before the water filters through the sand. This means that increased filtration rates are possible without deterioration in filtrate quality (Open, 2018).

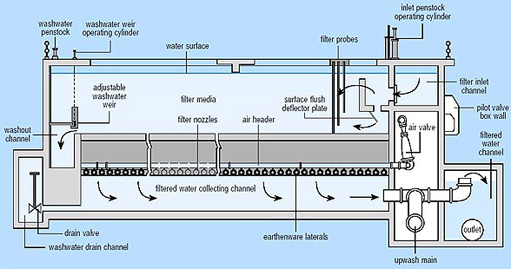


Figure 29 Section through a rapid gravity sand filter

1. **Disinfection**

Before water can be passed into the public supply, it is necessary to remove all potentially pathogenic micro-organisms. Since these micro-organisms are extremely small, it is not possible to guarantee their complete removal by sedimentation and filtration, so the water must be disinfected to ensure its quality. Disinfection is the inactivation of pathogenic organisms and is not to be confused with sterilisation, which is the destruction of all organisms (Open, 2018).

Worldwide, chlorine is the most popular disinfecting agent for drinking water, although the use of ozone has recently become more widespread. The use of chlorine in water treatment, while not being acceptable to all, does save lives. In Peru, the reduction of the chlorine dose led to a cholera outbreak in which thousands died. Chlorine acts as a strong oxidizing agent which can penetrate microbial cells, killing the micro-organisms. It kills most bacteria but not all viruses. It is relatively cheap and extremely soluble in water (up to 7000 g m−3). It has some disadvantages. If organics are present in the water being disinfected, it can lead to the formation of potentially carcinogenic disinfection by-products (e.g. trihalomethanes; see below). The World Health Organization has given health-based guidelines for a variety of disinfection by-products, such as chloroform. If the water has been previously treated by coagulation and flocculation, the chances of organic pollutants being present to form trihalomethanes are remote. Slow sand filters are effective in removing trace organics (Open, 2018).

Chlorine is a dangerous chemical and so requires careful handling. It can also give rise to taste and odour problems: for example, in the presence of phenols it forms *chlorophenols* which have a strong medicinal odour and taste (Open, 2018).

http://www.open.edu/openlearn/ocw/pluginfile.php/74181/mod_oucontent/oucontent/621/c120ecdd/f2b1db95/t210_1_ue0012i.jpg

HOCl, hypochlorous acid, is the disinfecting agent and is referred to as free available chlorine. Since chlorine is an oxidizing agent, it reacts with all compounds in water which can be oxidized, e.g. converting nitrites to nitrates, and sulphides to sulphates. As mentioned above, it also reacts with any organics present and can form trihalomethanes (THMs). These are single carbon compounds with the general formula CHX3 where X may be any halogen atom (e.g. chlorine, bromine, fluorine, iodine, or a combination of these). Some THMs are known to be carcinogenic. There is evidence to link long-term low-level exposure and rectal, intestinal and bladder cancers. There is therefore a limit of 100 μg l−1 for total THMs in water supplied for potable use. Chlorine also reacts with ammonia to form chloramines. Thus when chlorine is added to water there is an immediate chlorine demand which must be satisfied before a residual of chlorine exists for disinfection (Open, 2018).

The formation of chloramines is as shown below:

http://www.open.edu/openlearn/ocw/pluginfile.php/74181/mod_oucontent/oucontent/621/c120ecdd/329df49f/t210_1_ue0013i.jpg

http://www.open.edu/openlearn/ocw/pluginfile.php/74181/mod_oucontent/oucontent/621/c120ecdd/073f47bb/t210_1_ue0014i.jpg

http://www.open.edu/openlearn/ocw/pluginfile.php/74181/mod_oucontent/oucontent/621/c120ecdd/72f70d61/t210_1_ue0015i.jpg

The chloramines are disinfectants but not nearly as effective as free chlorine (they may have to be 25 times more concentrated to have the same effect).

Chlorine in compounds such as chloramines is referred to as combined residual chlorine. Although not as effective as free chlorine in disinfection, combined chlorine is less likely to produce objectionable tastes and smells. One reason for this is that combined chlorine does not react with phenols, which may be present, to form chlorophenols. In fact, ammonia is sometimes added to water for this reason. Combined residuals also last longer than free chlorine (Open, 2018).

For disinfection with chlorine, the World Health Organization (WHO) guidelines recommend a minimum free chlorine concentration of 0.5 mg l−1 after a contact time of 30 minutes at a pH less than 8, provided that the turbidity is less than 1 NTU. The water leaving the chlorine contact tank is usually discharged with a chlorine concentration of 0.5–1.0 g m−3 to ensure that the water is kept safe throughout the supply and distribution system (Open, 2018).

Concern with hazards of chlorine storage has led to the adoption of electrolytic generation of chlorine on large water treatment plants. In this process, sodium hypochlorite solution with a chlorine content of 6–9% is generated through the electrolysis of a solution of sodium chloride (Open, 2018).

Recently, *ozone* (O3, a blue gas and a very strong oxidizing agent) has become popular as a disinfectant, particularly as it is effective against viruses and spores. In the UK, it is often used to oxidize any pesticide residuals present. Also, ozonation does not produce toxic by-products such as trihalomethanes which can occur with chlorine. It can, however, form toxic bromates if bromine is present in the water. In France, there are about 600 water treatment plants using ozone as a disinfectant. The drawback with ozone, however, is that it is not possible to have a residual level, as there is for chlorine, to confer protection in the supply and distribution system (O3 rapidly breaks down to oxygen when any particles are present). In ultra-clean water, however, it will remain as O3). Hence, after ozonation, the water is chlorinated before it goes into the supply system. The ozone used in water treatment plants is usually generated by passing dry air or oxygen between plates, across which a high voltage is imposed. It is expensive to produce, and the necessary equipment is complex (Open, 2018).

Ultraviolet radiation can also be used to disinfect water, but care must be taken to ensure that no suspended solids are present which could shield the micro-organisms and prevent them from being destroyed. UV systems are generally only used in small-scale water treatment units. They do not give a residual for protection in the distribution system (Open, 2018).

1. **List the five factors that make a water source ideal to use.**

* *Volume of water required:* This will depend on demand, which relates to the number and type of potential users. Will the new source be able to meet the demand of all users? Have future increases in demand and population growth been taken into consideration?
* *Quality:* Is the water from a safe and protected source? If not, what will be the level of treatment needed and how will this be achieved? What is the risk of pollution of the source?
* *Seasonal variations:* Is the new water source reliable, or is it vulnerable to seasonal variations in the availability of water? How will this be accommodated?
* *Distance between source and users:* How far must the water be transported? What is the sort of distribution system that will be needed? What are the engineering requirements for the system?
* *Cost:* Following on from all the above, what is the cost of developing the new source (both capital and continuing operating and maintenance costs) into the future?
* *Environmental impact:* What are the predicted environmental consequences of developing the water source? Will the benefits of the new supply outweigh any disadvantages?
* *Sustainability:* Can the water source be developed and used in such a way that it does not compromise the future ability to supply water? For example, the rate of abstraction from a spring should not exceed the rate of natural replenishment (Open University, 2018).

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